A TREATISE

ON

SMOKY CHIMNEYS,

Their Cure and Prevention.

BY

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PREFACE.

Of those who have previously endeavored to enlighten the public with respect to remedies for so common a nuisance as a smoky chimney, Dr. Benjamin Franklin wrote a useful treatise in 1793; Mr. Robert Clavering, a builder, published an essay about the same time; Count Rumford gave much attention to the subject in his essays; a long article appeared in the first edition of the 'Encyclopædia Britannica,' which was afterwards published separately, and Mr. Eckstein, an ironmonger, issued a book, published by Weale, in 1852. No portion of the material of the present little treatise has been drawn from either of these sources, most of which the author had not heard of when he published his first edition, but he must, nevertheless, express that he is generally indebted to the labors of Count Rumford for much of the familiarity he has had upon matters relating to the domestic use of heat and the prevention of smoke.

Great Marlborough Street,

Dec. 2nd, 1867.

A TREATISE ON SMOKY CHIMNEYS.

About seventy years ago smoky chimneys in England were so common an evil, that not only were there no houses without them, but the chimney that would "draw" well in all states of the atmosphere, without the temporary assistance of an open window, was exceedingly rare. Count Rumford appeared, and, in essays which have gained esteem for the author of them, wherever they have been perused, established rules for the construction of our fire-places, which have procured for us the very large amount of fire-side comfort we now possess. In the course of fifty years, a smoky or doubtful chimney became the exception instead of the rule, and we can now wonder, that so long a period as a hundred and fifty years should have elapsed, from the time when coal became extensively used in domestic fire-places, before such simple and effective contrivances as those recommended by Count Rumford were even introduced.

It will be well to make a general examination into the various causes why many chimneys entirely, and others on certain occasions, fail to perform their proper functions, and to endeavor to ascertain whether or not, by the application of indubitable and recognized principles, they may be reduced in number to a very small residue, with which, short of their reconstruction, it would be worse than idle

for nay one to interfere. By indicating also the errors of construction in these and in many less difficult cases, we may observe much that should be avoided in the future.

It may be useful to state, in a few words, how heat operates in our fire-places, to carry off smoke and other products of combustion. It is well known that when air becomes heated by radiation from the earth, or any other medium, it instantly expands and rises, cooler air filling its place to be heated in its turn, to expand and to rise. The upward passage of such air becomes arrested by its having gradually parted with its heat, and lost with it, its comparatively rarefied condition. In a closed building, the passage of heated air is arrested by a roof; so, also, in an apartment, by the ceiling, where, unless there are disturbing causes, the coldest air will naturally be near the floor, and the warmest near the ceiling. As soon as the air in a house or a room attains a temperature exceeding the external, there is a constant tendency for the colder air to enter by every, even the smallest, opening, and to displace the warmer and lighter air, which, as a rule, seeks higher points for escape. If a window be opened above and below, the quantity of air entering by the lower aperture will displace a similar quantity escaping at top, or by the chimney. If a door of a room be opened, where a fire is burning, a current of air rushing in at bottom may be observed with the aid of a lighted paper and a reverse current at top. If air is excluded altogether from entering a room, either by door or window, it inevitably enters by the chimney, provided only that the external air is colder, and therefore heavier and denser than the air in the room. The simple conditions upon which we depend, that there shall be an upward current in a chimney, are—1st. That the air in the room is warmer

than the external air. 2nd. That the external air has freer means of entrance to the room than by the chimney, viz. by the openings round a door or window, that the displaced air may find its point of escape at the chimney. It will be obvious from this, that if houses are constructed so as to allow a free entrance to external air at many points, the chimneys perform the office of channels of exit for rarefied air. If this is not attended to, or is intentionally frustrated, air enters by the chimneys.

When a fire is made in an open fire-place, air becomes heated by contact with the burning fuel, and immediately rises, carrying with it smoke, carbonic acid, &c. If there is an upward current of air in the chimney, the products securely pass away. If, on the contrary, there is a down current, they are instantly emitted into the room. If there is no current at all, and the air is therefore stationary, the rise of heated air from the fire warms the air in the chimney, and an upward current is established, which is accelerated according to the degree of intensity with which the fire burns. The more the air in the room becomes warmed and rarefied, the greater is the force with which the external air rushes in by the doors and windows, and supplies that pressure of air from the room by virtue of which the ascensional current is maintained. If the general body of air in the room is allowed to become more rarefied than the general body of air in the chimney, air flows from the chimney to the room, bringing smoke with it. If, on the contrary, the air in the room is maintained in a less rarefied state than the air in the chimney, the ascending current continues. Having thus explained the simplest view which can be taken of the action of chimneys, we will enquire what are the disturbing causes which hinder them from performing their proper functions; in other words, why they sometimes "smoke."

Cause 1.—From a fire-place being too open.

Cause 2.—From the doors and windows of a room being fitted too closely.

Cause 3.—From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

Cause 4.—From a chimney being very short.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Cause 6.—From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.

Cause 7.—From low buildings being attached to higher ones in which the air becomes rarefied, there being direct means of communication between the two.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

Cause 9.—From the top of a chimney being situated below a pitched roof.

Cause 10.—From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.

Cause 11.—From low buildings with short chimneys being contiguous to higher buildings.

Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.

Cause 13.—From chimneys of one house being lower than those of one adjoining.

Cause 14.—From chimneys in elevated situations being exposed to heavy gales of wind.

Cause 15.—From a chimney being too small for the fire-grate used.

Cause 16.—From one chimney being made to serve for two fire-places.

This appears to be a rather imposing list. It will be found, however, that some of the causes are so similar in nature as to be nearly identical, and that the remedies are, without exception, referable to very few and simple principles. Two other causes may be mentioned, which require no discussion; viz. that sometimes a chimney is found to be unsound, and, in consequence of a crack, admits a body of cold air; and, that a chimney which has given considerable annoyance and puzzled many practitioners, has been found to have no other fault than that of having become accidentally stopped in some part by a mass of fallen brickwork.

Cause 1.—*From a fire-place being too open.*

Questions relative to the proper construction of fire-grates have been entered into at length in another treatise,* but, some leading recommendations necessary for the proper elucidation of the subject now under discussion may be here reproduced. A fire-place more open than is necessary, for the most effectual use of an open fire, is the old evil so much combated by Count Rumford, and even now, probably, the most frequent cause of a smoky chimney. Fig. 1 represents an old-fashioned grate with hobs, in which the Count's recommendations have been almost entirely disregarded. When a fire is lighted in such a grate, if there does not happen to be a good upward current in the chimney, an immediate effect produced by the rising of warm air is a rush of cooler air from the spaces over the hobs, which drives smoke into the room. If, however,

* 'Our Domestic Fire-places, a Treatise on the Economical Use of Fuel and the Prevention of Smoke, with Observations on the Patent Laws.' 2nd edition. By the Author.

the hobs are discarded, and if air from the room can, therefore, only press to the chimney directly over or from between the fire-bars, no hindrance from such a cause can prevent the proper escape of smoke. A farther inducement to discard such grates is that their form is very inappropriate for the effectual radiation of heat. The metal sides and back, *a*, *a*, *a*, receive a considerable amount of heat by conduction, which heat, however, they communicate chiefly to the currents of air which pass up the chimney and to the brick-work behind, so that the metal remains comparatively cool and radiates little heat. If, however, the back and sides of a grate are formed of fire-brick, which, being a non-conductor of heat, retains in a very great measure the heat it receives and therefore radiates powerfully; if they are continued straight up from the fire, as shown in fig. 2, and if the sides are placed at such an angle as to radiate in a proper direction the heat they receive, a fire will burn much brighter, and with far greater economy of consumption, than in a grate of the former description.

But it is not merely necessary, on the score of efficiency and economy, to use grates of a contracted form instead of the old-fashioned open ones. It is necessary, even with modern grates, to have special means for regulating the opening into the chimney, and such means as can be used once a day, if necessary, without inconvenience. If no such means are provided, a considerable quantity of air, warmed by contact with the burning fuel and some heated parts of the grate, escapes at every moment freely up the chimney. The effect of such free escape of air is, that colder air rushes in by the doors and windows with much energy, and passes at once to the most rarefied part of the room, viz., to that in the neighborhood of the fire-place, thereby creating disagreeable draughts. Many may suppose that

a very free escape for air by the chimney is promotive of ventilation, and it certainly is so, but to provide effectual means for insuring a proper change in the air of the room can be attained without allowing constant currents of perfectly fresh air to rush across the room and escape by the chimney, for it must be remembered that, when a fire is burning, it is the coldest air, that which comes fresh from outside, which rushes with greatest force to the fire-place, and forms the greater porportion of what escapes.

It may also be said that a free escape of warm air up the chimney improves the current and effectually carries off the smoke. This is true, and it is well to make the current secure; but, if the upward current is much more than secure, we make a great portion of the coal burnt to answer a most unnecessary purpose, and we are inevitably inconvenienced by draughts of cold air. Fig. 2, and the section fig. 3, represent a grate with an improved register door or regulating valve, *c*, which can be opened and partially or wholly closed by a handle, *b*, in front of the grate. When a fire is lighted the regulator is generally fully opened. As soon as the coal is well ignited the regulator is closed about two-thirds. The handle, *b*, should be of a non-conducting material, such as ebony, bone, or ivory, which could be used by any person without inconvenience. An ordinary register door in a chimney, can, of course, be made to answer the same purpose, provided it is systematically used. It should, as a rule, be left open just sufficient to allow all the smoke to escape, and no more.

A certain kind of grate, formerly much in use, and now revived, called a Dog or Pillar Grate, often occasions a great deal of trouble from smoke, in consequence of its very open form. Fig. 5 is a sketch of such a grate, and fig. 6 shows how a contracted form can be given to it,

by iron sides, *a*, *a*, and a plate, *b*. A regulator, *c*, may control the passage of air to the chimney, and a sliding blower, *e*, fig. 7, may render the grate as little likely to occasion inconvenience as any other.

Fig. 8, represents a highly useful and ingenious arrangement, suggested by Sylvester, called a "louvre back," which enables the chimney to be greatly contracted, and, at the same time, leaves the fire-place open. The section shows a series of iron plates, *a*, *a*, *a*, *a*, between which the smoke passes into the flue or chamber, behind, and thence to the chimney, as indicated by the arrows. There is no entrance whatever to the chimney, except between those plates, which may be opened at pleasure by a touch with a poker. When a fire is lighted, a steady current of warm air rapidly carries off the smoke and other products of combustion, without occasioning inconvenience.

The preceding principles of improving the draught of chimneys, and preventing the nuisance of smoke, either by using contracted grates or by retaining open ones, and using contracted means of exit behind, can be applied to every description of grate made to be used with an open fire. Fig. 29, represents one of the abominable structures in metal, with a large open space above, such as is commonly put into a laborer's cottage, and into the attics of larger houses. Fig. 30, represents the same fire-place contracted, with the fire-bars only of metal; with fire-bricks to form the back and sides, and pieces of slate or other material to reduce the size of the opening. The former fire-place could seldom or never be used without the nuisance of smoke; the latter, with the aid of a piece of iron to cover part of the fire-place in front at the time of lighting the fire, would, generally, of itself be a sufficient cure from smoke, and it is no figure of speech to say, that it would give about twice as much heat as the other from the same consumption of coal.

Those, however, who wish to retain such a grate as fig. 29, may reduce its liability to one evil, by closing the entrance to the chimney above, and providing means of exit behind the grate, on the principle already described. Fig. 28, shows an ingenious contrivance, used by intelligent bricklayers, called a "back-draught plate," which enables the fire-place to be contracted, and, at the same time, leaves the hobs free for domestic use. This article is fixed, as shown in fig. 32, with an opening to the chimney behind it, and an opening in front, half-an-inch broad, and of the width of the draught-plate. When a fire is lighted, a condensed current of warm-air rapidly ensues, and passes behind the "draught-plate" to the chimney, any smoke or vapor arising direct from the fire escaping by the narrow opening, *b*, in front of the plate.

Cause 2.—From the doors and windows of a room being fitted too closely.

While some persons are in favor of allowing too great a freedom for the passage of air through rooms, others go to the opposite extreme, and try to exclude fresh air altogether. Draughts of cold air are certainly very unpleasant, and sometimes render small rooms almost uninhabitable in winter; but, the evil cannot be remedied by depriving the chimney of that pressure of air from the room which is absolutely necessary to prevent a down current. When we state that a fire burns, we mean that a certain quantity of air is becoming decomposed by the combination of its active element, oxygen, with the carbon and hydrogen of the coal, producing thereby heat and flame. The air for this object is taken entirely from the room, if there is no free ingress for air from another source. Partly by the process

of combustion, partly by the passage of undecomposed air up the chimney, and, partly by expansion from heat, the air in a room often becomes exceedingly rarefied, and if fresh air is not allowed to enter with some freedom, the air becomes in fact more rarefied than the air in the chimney itself. The inevitable consequence is that the air in the chimney being no longer supported by the pressure of air from the room, the balance becomes turned in the wrong direction, and air flows into the room from the chimney, bringing smoke and offensive vapour with it. The best chimney in the world may be readily made to smoke by the simple process of excluding the entrance of fresh air to a room.

By far the best remedy is to provide a special supply of air to the fire, which ensures a constant supply with but little assistance from doors and windows. It is commonly effected by means of a tube communicating with an external wall, and passing between the joists to some opening in the neighborhood of the fireplace. The opening is sometimes in the hearth-stone, and is covered by an open grating, the bottom plate of the fender being pierced with a number of holes. At other times, the tube is carried behind the grate, and the air is allowed to enter the room by openings at bottom near to the fire, as shown at *d*, *d*, fig. 2. The latter arrangement may be considered to be the best, as dust and cinders are less likely to enter the open spaces than in the former. Many persons who have adopted the principle now suggested, have made the error of using tubes much too small. The tube should have an area of not less than that of the opening into the chimney when the register or regulator is in its usual position, with a good fire burning. This should give about twenty-eight square inches for a room containing a thousand cubic feet of air, and four

square inches more for every additional thousand cubic feet. For a room therefore measuring twenty feet by fifteen, and ten feet high, a tube six inches square, or four inches by nine inches would be suitable. A regulator is always neeessary to admit or shut off the air, and a grating at the other extremity of the tube in the outside wall. The regulator and grating will aet as impediments, and generally eause a little less air to enter the room than ean pass away by the ehimney. This however is unimportant, provided the tube is of sueh a size as that mentioned, and the grating and ventilator are as large as convenient. A considerable quantity of air will then inevitably enter the room and effeetually prevent annoyance from draughts.

If it be eonsidered impracticable to give a special supply of air to the fire, sufficient aceess must be provided by the usual means. If any one has to bear, however, with the inconvenience of draughts of eold air, it may be observed that the evil would be redueed to a minimum by the use of those grates which allow the smallest quantity of air to ascend the ehimney. These are the contracted grates, with the regulating valve in the ehimney, to which reference has already been made.

Cause 3.—*From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.*

This cause is similar to the last, but more complicated. When fires are burning in rooms immediately adjoining, and eonneeted by a door, or folding doors, it is generally found that the ascending current from one fire-plaec is mueh stronger than from the other. For a short time, both fires may burn very well; but, when the air in the rooms becomes rarefied, a downward current ensues from

the chimney of weaker draught, bringing smoke and vapor. There are generally two ways of remedying the evil; the first, to reduce the quantity of air that can escape by the chimneys, so that no larger quantity of air may pass from the room than can readily enter it; the second, to allow of the free entrance of as large a quantity of fresh air as can possibly escape by the chimneys. It is highly advisable in the first place to see that the grates are so arranged, that they will permit no more air to pass from the room than is really necessary to support combustion, and maintain the effectual working of the chimneys, the means for accomplishing which have been fully explained in the last section, and in a former treatise. Though, in two badly arranged fire-places, the pressure of air from the rooms may be insufficient to prevent a descent of air and smoke in one chimney, directly the fire-places are improved, and, by the use of contracted grates or regulators, the amount of air which can pass up the chimneys from the rooms is greatly diminished in quantity, the air in the chimneys then attains a higher temperature, and becomes, therefore, far more rarefied than before, and it is, consequently, easily upheld by the much less rarefied air of the rooms. The evil is of various degrees of intensity, and, generally, the use of contracted grates and regulators, or register doors to the chimneys opened just sufficient for the smoke to escape, is all that is required; but, if the doors and windows are fitted very closely, a modification of the existing grates, or their substitution by others of better construction, will be insufficient to remedy the evil, and facility for the ingress of a greater quantity of air to the rooms must be given.

Fresh air ventilators in a window, wall, or door, or a special supply of air to the fire, as mentioned in the last section, will be effectual.

Cause 4.—*From a chimney being very short.*

An attic, or other short chimney, often smokes in consequence of the pressure of the atmosphere at the top of the chimney being greater in power than the ascensional force of heated air from the fire, so that a downward current ensues and turns back the smoke. Anything that will give a preponderating power to the upward current will remedy this evil. The heightening of the chimney, by means of a zinc pipe, is usually resorted to, as it is well-known that the ascensional current in a long chimney is generally much better than in a short one. This results from the well-known law that, when there is a difference of temperature between the air in a chimney and that situated externally, the air inside moves with a certain accelerated velocity, according to the length of the chimney. A long chimney does not, of course, absolutely create a current, but, as the brickwork inside it is not so easily cooled by the action of the cold air from above, as in the case of the short chimney, the whole of which is as much exposed to this cooling influence as the upper part only of the long chimney, an upward current can usually be created in the long chimney, with very little difficulty, if it does not already exist; and that current becomes, quickly, much more powerful than one in a short chimney, if other conditions are equal. Before deciding whether or not so unsightly an object as a lengthened chimney must be accepted as a necessary evil, we may enquire what other modes of improving the working of a short chimney, can be found to be effectual.

A law of very great importance in its relation to a fireplace is, that the greater the difference of temperature between two bodies of air, the greater is the velocity with which the lighter ascends, or is forced up by the other;

or, in other words, the greater is its force. Therefore, the colder the air is in a room and the warmer the air is which rises from a fire, the greater is the force with which the warm air rushes, or is impelled, into the atmosphere. The air in rooms with low chimneys, as attics, in laborers' cottages, &c. does not commonly become very rarefied; the doors and windows in such places are not usually fitted with too much care to exclude air; they consequently do not suffer from an evil mentioned before, and the pressure of air below we may therefore assume to be usually sufficient. It has been shown already that the effect of a contracted fire-place is to prevent local currents of air from driving puffs of smoke into a room, and to give consistence to the column of heated air rising from the burning fuel. It has also been shown, that a current becomes so accelerated in long chimneys, that such current requires to be checked. Now, if we apply these considerations to a short chimney, we shall see, that what is calculated to check the current in a long chimney, is less necessary in a short one, where a current is sometimes not easily obtained at all; but, that whatever is calculated to develop and increase the current in a long chimney, should be applied to the short chimney in a much greater degree. A regulating valve, where there is little or no upward current to check, and generally a reverse one, is therefore practically useless, except when a good upward current has been established. The valve would therefore generally be left wide open. What is wanted is something of exactly the opposite nature; viz., means of establishing or increasing the current, and this is gained simply by an extension of the principle of contracting the fire-place. If, to a contracted grate, a sliding curtain or blower is used, as shown in fig. 4, an upward current is instantly improved if the fire is already burning. The reason why an extra contraction of the fire-place

greatly increases the ascensional force of air from the fire, is as follows. By partly closing the space between the bars and the chimney, we reduce the amount of air that can readily find access to the chimney from the room, and the air in the space over the fire, which is temporarily closed in front by the blower, becomes highly rarefied. The warmer this space becomes, the more the air presses from the room into the chimney, and, as this air is obliged to pass in near contact with the fire over and between the fire-bars, it attains a considerable temperature. The rush of air rapidly increases; the burning of the fuel is accelerated by the rapidity of the air; the fuel in turn acts with increased intensity in heating the chimney, and an upward current becomes thus easily established, where none before existed. Though, however, an upward current can, under very many circumstances, be created by such powerful means as a blower, the advantage is not gained without extravagance of consumption, little heat where it is most desired, and the use of a contrivance which might from inattention be greatly misused. The blower, therefore, should never be used except for a few minutes after lighting the fire, but its necessity may sometimes be avoided altogether, by reducing the height of the fire-place. If the space above the top bar of the grate did not exceed twelve inches in height, a blower, in many instances would never be required. And it must be borne in mind that the only heat which may be considered to be lost by this practice, is that radiated by the upper part of a grate, which is not considerable.

A short chimney can be further improved by reducing it in size. The less the size of a chimney, the less the quantity of cold air it contains, and, therefore, the more easily that air is heated, and the greater the force with which it moves. But, in reducing the size of a chimney,

it is most important that ample space should be left for a body of air, sufficient in volume to remove the smoke and offensive gases resulting from combustion. If the chimney were reduced to the size of the fire itself, it would be more than sufficient, and in a room measuring twelve feet square, a flue nine inches by four-and-a-half inches would amply suffice to remove the products of combustion from a contracted fire-grate of the dimensions required.

To reduce the size of a chimney would be, however, rather a troublesome and expensive operation, and, it may be well, therefore, to point out how the object aimed at may be effected, in a considerable measure, by simpler means. Fig. 9 is a sketch of a metal tube, measuring in the upper part nine inches by four inches and a half, and in the opening below, nine inches by seven inches and a half. If this be applied to a short chimney, just above the grate, and out of the sight of a person sitting, and if the opening to the chimney be closed, so that no air can pass except through the tube, the lower part of the chimney will be effectually reduced in size, and the heated air from the fire, will, therefore, have the consistence and force so necessary in a short chimney. The longer the tube, the better it will answer its purpose. Practically, it should not be less than eighteen inches, and may often conveniently be as long as from three to five feet. If, also, the top of the chimney be reduced, by some very simple method, to the same dimensions as the small part of the tube, the chimney will become nearly as efficient as if reduced to the same dimensions throughout.

Fig. 10 represents an iron frame, with an opening of the same dimensions as the lower part of fig. 9, without its projecting rims, which could be built into the chimney. To this the funnel-tube could be attached from below by means of turnbuckles, made to enter corresponding

holes in the rims of the tube and the frame. This would enable the tube to be removed with facility for the purpose of sweeping the chimney, or removing any soot that might have fallen around the tube.

It would be a troublesome matter to apply a regulating valve to the tube; and, as such an article would generally be practically useless, in consequence of there being no considerable current to be checked by it, its use might be dispensed with in short chimneys.

When a chimney is heightened considerably, it becomes immediately more serviceable. The down-current becomes less intense, and can with greater facility be converted into an upward current; but, as a remedy, it cannot be depended upon alone. When a chimney is heightened by a zinc flue, for instance, which is the mode usually adopted, this flue is acted upon by the external air; and, when a fire is extinguished, the cold external air may check the upward current, and convert it into a downward current, which has, perhaps, to be reversed with difficulty the next time a fire is required. As, therefore, a heightened chimney is not necessarily entirely effectual, and is generally very unsightly, it is far preferable to improve a short chimney by reducing it in size, or by reducing the apertures of ingress and egress; and, also, by giving such attention to the fire-place as will not only render it easy for an upward current to be developed, but will be followed by excellent results in warmth and economy. That to heighten a chimney might still further improve the action of the fire-place, is evident. Short chimneys adjoining or surrounded by higher buildings, are considered under Causes 7 and 11.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Chimneys in London are usually built in party-walls, and are not, therefore, exposed to be cooled by the action of air, except through the entrance of cold air above or below; but, a chimney in an external wall has exposed brickwork, which becomes damp and cold unless constantly defended by a heated current. As the thermometer falls, the exposed brickwork becomes reduced in temperature. It cools by contact the air in the inside, and as soon as such air becomes colder, and therefore, heavier, than the air in the apartment below, a downward current ensues, which becomes accelerated the more the cooling influence increases. Such a chimney may be much improved by simply increasing the thickness of the brickwork on the exposed side. Such a remedy is, of course, attended with rather considerable expense. The brickwork should be increased from four-and-a-half inches in thickness, which it frequently is, in such a position, to nine inches.

Another remedy is at the fire-place. As the difficulty to be encountered is exactly the same as in a short chimney, viz., to convert a downward current into an ascending one, it is equally essential that there should be reasonable access for air to the room, by doors and windows, and that the space between the bars and the chimney should be temporarily reduced by a blower, to enable a body of air to become speedily warmed.

As in the former case, a low fire-place is much better than a high one, and a chimney no larger than really necessary for the escape of smoke, greatly diminishes the evil to be overcome. The extremities of the chimney may therefore generally be reduced, but only with great

caution. It is better that a chimney should be too large than too small, for, if the products of combustion cannot pass away with sufficient freedom, a portion will inevitably enter the room. The funnel-tube, fig. 9, described in the last section, will do very well for a small room, and it may be adopted on other occasions, simply by making it of wider dimensions throughout than nine inches.

If, in any case, it be made a little less in width than the width of the fire chamber, so that it can be placed or removed without difficulty, and if the dimensions of four and a half inches above and seven and a half inches below be retained, there will in all ordinary cases be ample facility for the escape of smoke. It need hardly be mentioned that the particulars given are not of absolute necessity, and that the funnel-tube can be modified in a great measure according to requirement. It may be made of less height, and the sides may slope instead of being at right angles with the front and back, if such an arrangement will render it better adapted for the fire-place.

If the external chimney be from a dining room, or a drawing room, a preferable grate may be used to that shown in fig. 4, which may simply be regarded as the type of a good contracted grate. Fig. 11 represents a grate known as Stephen's patent. This has a very contracted form, but the contraction is behind the fire instead of in front of it. The current from the fire passes through a small door at the back of the grate, and, as the air becomes highly heated by passing over the burning fuel, an upward current can be quickly created and increased. The end gained is the same as by fig. 4, but, there is this advantage in using the Stephen's grate instead of an ordinary grate with a sliding blower to it, viz.: that a good current is gained, at less cost, in consequence of the surface of the burning fuel, both at top and in front, being fully exposed to the

room, even when the aperture to the chimney is most contracted. In fig. 4 it will be seen that when the blower is drawn down, the upper surface of the fire radiates its heat into the chimney, but in fig. 11 it constantly radiates it into the room, or on the arched reflecting surface of the grate.

The door, *a*, is moved backwards and forwards on a hinge; but, in another grate, known as King's Patent, fig. 13, it is moved up and down, being balanced by means of chains and weights. The latter description of door is most effectual for increasing or checking the draught. Both Stephen's and King's grates are admirable for several reasons. They give a very cheerful fire, look well, and they effectually warm large rooms; but, when properly made, they are more expensive than others, and they are not the most economical in use. An external chimney in a wall facing the south or west is, for an obvious reason, less difficult to deal with than when the wall faces the east or north.

Cause 6.—*From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.*

This is an extension of the last evil, and the remedy is, therefore, a matter of greater difficulty. When a chimney is built in the angle of a house, with two sides exposed, or against a wall, with three sides exposed, and when the brickwork is no thicker than four and a half inches, the case constitutes, frequently, one of the most inveterate smoky chimneys that are encountered. The contracted fire-place, with the sliding blower, or a Stephen's grate is indispensable. There must be an amply sufficient supply of air to the room, and the top of the chimney may

frequently be reduced as already described. Of the greatest assistance it would also be to reconstruct the chimney of nine inch brickwork.

Cause 7.—From low buildings being attached to higher ones, in which the air becomes rarefied, there being direct means of communication between the two.

This is a very difficult case, and generally comprises most of the ills of suffering chimneys. If, in public buildings, such as the Crystal Palace and St. James's Hall, there are apartments, or offices, with low chimneys, communicating immediately by doors with the main body of the building; whenever the air in this is more rarefied than that in the offices, air flows from the latter into the former as naturally as cold air enters a warm room by an open window. As the air passes from the room, colder air enters round the window and descends the chimney. We have in such a case a strong descending current, generally an external chimney, a low chimney, and one probably affected by wind, in consequence of its being below higher buildings, a cause which will be discussed further on. Every cause should be dealt with by itself. Air should be prevented from flowing into the main building by carefully-fitted double doors. If the room be well supplied with air from special sources there will be a proper pressure to assist the upward current. The most contracted form of grate can be used, as figs. 4, 11, or 13. The external chimney and the low chimney can be improved by the means already indicated, and, finally, the descent of wind on the top of the chimney can be met by a simple protection, as described for Cause 11. It will often be of lesser consideration to heat such places by means of hot-water pipes than to attempt the rectification of the fire-places and chimneys.

The same difficulty is often encountered in a private residence. A man builds an extra room at the back or side of his house, which he hopes to use for his dining room or library. He builds a short chimney, and, when the air in his house is rarefied, cold air descends his chimney like a plummet, rendering it often impossible for a fire to be used. He should see that his house is reasonably supplied with air; fit his door of communication closely, or use a double door; give a special supply of air to his room; use a contracted grate; reduce the apertures of his chimney according to the instructions already given; heighten his chimney, if it can be done inoffensively, and place a protection on the top against the descent of wind.

Those intending to make such an addition to their houses in future, would do well to build their fire-places against their outside wall, and to construct a good chimney of the extreme height of their main building.

Cause 8.—*From a down current in a fire-place bringing smoke from an adjoining chimney.*

A descending current in a chimney takes place whenever the air in a house or room is more rarefied than that in the chimney itself, so that, on smoke emerging from an adjoining chimney, it may return to the house in the down current. The evil is sometimes remedied by increasing considerably the height of one of the chimneys, not, surely, an agreeable sight. If rooms were duly supplied with air, return smoke from another fire-place could hardly be known. One remedy is to use a carefully fitting regulator to the chimney as shown in fig. 3, or any similar contrivance which would allow of the chimney being effectually closed. Another plan is to put a division piece between the chimneys at top, of stone or other material, about eighteen inches high, and as wide as convenient.

Cause 9.—*From the top of a chimney being situated below a pitched roof.*

In the previous sections, the difficulty to be encountered has been a down current in a chimney, but, we come now to a class of cases which are entirely different, and in which the obstructing agent is the wind. A pitched roof offers obstruction to the wind which strikes against it, and often rebounds upon a chimney situated below; or the wind, passing over the pitched roof in rushing to more rarefied strata of air on a lower level, strikes violently the ascending current of air from a chimney and drives it back with the smoke in spite of any protection there may be to the top of the chimney. An effectual remedy is to raise the height of the chimney above the obstructing roof. It is far better to do this by means of brickwork, which can be particolored in ornamental buildings, and surmounted by an ornamental chimney-pot in earthenware, than to use a tube of zinc or other metal.

In modern dwelling houses, it is usual to build the chimney stacks very low, sometimes scarcely as high as the roof, and consequently all the chimneys are found to smoke a little when the wind is in such a quarter as to descend from the roof upon them. In this one particular, we have certainly not become wiser than our forefathers. The houses in Bloomsbury, for instance, have chimney stacks carried completely above the roofs of the houses, and the evidence of sight may convince us that they can have few smoky chimneys. If the builders of our new dwellings will carry their chimneys high enough to be clearly above the ridge of the roof, we need hardly fear that we shall see them terminated by unsightly appendages.

Fig. 15 is a sketch of the roof of the Middle Temple Library. The pressure of air flowing over the high-

pitched roof was often so great that the chimneys were practically useless, even with the fire-places well constructed. Ultimately, after a great deal of trouble, the chimneys were stopped above, and, metal flues, connected with them below, were carried up the sloping roof, as shown at *b*, *b*, *b*, *b*. Fig. 16 is submitted as exhibiting a reasonable suggestion for encountering the evil. By closing carefully the chimneys on the side nearest to the roof; by placing a simple protection at top, and providing a place of escape for the smoke on the opposite side only, it may be supposed that the smoke would escape without obstruction from any wind that might flow over the roof. If the wind were supposed to act in the opposite direction, as shown on the left side of the section, a shield, *c*, would probably be an ample protection.

Cause 10.—*From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.*

This is another cause of an inveterate smoky chimney. A tower is usually an ornamental structure, but sometimes more ornamental than useful. If it is situated in close proximity to a chimney, the latter often smokes. The wind strikes the tower and rebounds on the chimney, or, if the wind comes from an opposite direction, and gains, by any means, a downward tendency, it prevents the smoke from emerging, as in the last case. The difficulty is often complicated by the chimney top being situated below a pitched roof, also by the chimney being in an external wall, and perhaps very short. Every cause must be, of course, dealt with. The fire-place should be treated in the manner found necessary for short chimneys; the thickness of the exposed brickwork might be increased if practicable; the chimney should be carried above the height of the

sloping roof, and, lastly, a protection, but of a very simple nature, should be furnished to the top of the chimney. The simplest and most obvious form of protection against a violent descent of air is a sloping roof, as shown in figs. 17 and 18, which could be constructed either of earthenware or metal. In using any such contrivance great care must be taken to leave sufficiently free egress for the smoke.

Figs. 19, 21 and 25 show other forms of protection.

Cause 11.—*From low buildings with short chimneys being contiguous to higher buildings.*

Masses of cold air flow over the tops of our houses and descend into our streets and other open spaces. When there is a low chimney, as in the case stated, the pressure or force of the descending air is often so great as to overpower the upward pressure of the air escaping from the chimney, and a downward current ensues, totally regardless of any contrivance there may be on the top to prevent it. The evil may be most effectually remedied by building a chimney against an adjoining wall and carrying it above the roof. There may be a difficulty, however, in applying such a remedy, irrespective of expense; and, therefore whatever means are calculated to improve the upward current may be used to diminish the evil. The due supply of air below, the contracted grate, the blower, the reduced chimney, the lengthened chimney within convenient limits, and the protection at top, will reduce the evil to a minimum that may cause annoyance at very rare intervals, if ever at all. Such a protection as fig. 17 is both simple and effectual. Figs. 19 and 21 are more unsightly, but afford a very good protection in extreme cases.

Cause 12.—*From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.*

When masses of air flowing from hills to lower levels strike the backs of houses, a portion of the air may rebound upon low chimneys of outbuildings, or the wind may descend directly upon the chimneys; and, if the pressure of the flowing air be considerable, a very powerful descending current may sometimes ensue, rendering it quite impossible for a fire to be kindled. In such a case there can hardly be a choice of remedies, and the judicious course is to meet the evil at once, by building the chimneys against the back walls of the extreme height of the main buildings. If, however, the chimneys are at some distance from the houses, the remedies for short chimneys can be adopted. The evil cannot, in that case, be of the utmost severity.

Cause 13.—*From chimneys of one house being lower than those of one adjoining.*

If the wind in passing over the roofs of houses strikes one of greater elevation, it rebounds upon contiguous chimneys that are below. In such cases a protecting roof to chimneys, as fig. 17 or 18, will be of great use. The wind-guard, fig. 22 or 24, would be equally effectual.

Cause 14.—*From chimneys in elevated situations being exposed to a heavy gale of wind.*

In this section chimneys are referred to which rise completely above the roof of a house, and are not "commanded" by anything contiguous which might tend to give the flowing air a downward tendency. Such chimneys cannot smoke except on extraordinary occasions. It is sometimes found that the wind passes over the tops of

chimneys with such force and continuity, that little or nothing can escape from the chimneys for some minutes together. What is required is something to break the force of the wind, so as to give the smoke a chance of escaping. A simple form is in all cases the best, as it is least likely to get choked with soot, and anything complicated is totally unnecessary. A wind-guard, such as fig. 19, 21, or 23, allows the wind to strike against it for any length of time, and still leaves freedom for the smoke to escape. By applying the principles indicated in these figures, an ornamental stack of chimneys may be terminated with uniformity, and be not therefore very objectionable to the sight. It is only in elevated situations in the country or at the sea side that chimneys fully exposed are found sometimes to require protection against air moving horizontally. In towns and protected situations generally, the experience of every one must convince them that the gales they are exposed to are too fitful to occasion universal inconvenience.

Cause 15.—*From a chimney being too small for the fire-grate used.*

This is quite a modern cause for an ineffective chimney. Many persons have considered that our chimneys are too large, and, without considering the question with sufficient fulness, have unfortunately given dimensions for the construction of chimneys much too small. The best grate for a small chimney is that which allows the least air to escape, viz. the contracted description before referred to. But, if the chimney is too small for any ordinary grate, we may suppose of six-inch drain pipes, there is no remedy but to use a stove that requires far less air than an open fire-place, or to re-construct the chimney of more suitable dimensions.

Cause 16.—*From one chimney being made to serve for two fire-places.*

In ordinary fire-places, a considerable body of air passes up the chimney, and, when an extra opening is made in the chimney, and another fire-place is constructed, it is found that the chimney is not of sufficient capacity for the escape of the two columns of air. One of the fire-places is therefore useless, and smoke returns to the room. The proper remedy is to diminish as much as possible the quantity of air that can pass up each fire-place by means of contracted grates, and the regulator shown in fig. 3, or by something to answer the same purpose, which should never be opened more than necessary for the free escape of smoke. A chimney that was only sufficient for one grate may thus suffice for two. It is also very essential that there should be no deficient supply of air to both rooms.

A descending flue from a stove is often carried into a chimney which is used for another purpose; but to enter upon this matter would entail a discussion of the whole subject of descending flues, which should form part of a treatise on close or pedestal stoves.

On kitchen fire-places.

The last of the enumerated causes for a smoky chimney having been noticed, it will be well to say a few words on the application of the foregoing principles to kitchen fire-places. An old-fashioned kitchen range, it is well known, has a large open fire-place, with a yawning chimney immediately over. Such a fire-place can be contracted in the manner shown in figs. 26 and 27. The open spaces above the hobs leading to the chimney should be entirely closed, and two upright pieces, *a*, *a*, fig. 26, shown by

dotted lines in fig. 27, should confine the passage to the chimney at each side. A piece of iron, *b*, placed across in a sloping direction, and fastened at each end to the two side pieces, will act as a check to the quantity of air that can press to the chimney from the room. The air in the chimney will become in consequence far more rarefied, and the air which passes over the fire and enters the chimney, will have, therefore, far greater ascensional power than before. A blower, *c*, will assist to contract the open space, and if an opening, *d*, be left at the top of the sloping plate, any smoke rising directly from the fire will readily escape.

A kitchen is usually abundantly supplied with air, but, there is an impediment peculiar to such a place of very common occurrence. Our builders are generally judicious enough to provide our kitchens with chimneys of sufficient capacity to carry off the considerable quantity of warm air which we discharge into the atmosphere; but, it is no uncommon thing to find that the escape of the air and smoke is checked by a very small chimney pot being used, as a fitting termination, to a large chimney. The upward force of a large volume of air being greatly checked, the external cold air often prevails, enters the chimney and drives back the smoke. A chimney pot to a kitchen should not generally be less than twelve inches in diameter in the inside.

The description of kitchen range commonly used for cottages and small families, shown in fig. 31, can have the method of contraction already described in page 9, viz. by the fire-place behind the mouth being closed, and the "back-draught plate," fig. 28, protecting the entrance to the chimney, as shown in figs. 29, 31 and 32. A preferable arrangement, however, is to dispense with such a cooking range altogether. The cooking stoves con-

structed on the principle of those used on the continent and in America, are cleaner, more effectual and economical, and not in the least liable "to smoke." Many years since, Captain Grant introduced one of the kind in this country, which was similar in form to fig. 33. The chimney should be always closed above by means of brickwork and a moveable door, so that there might be no entrance to the chimney for the smoke except by the pipe *a*. The stove is best adapted for burning coke.

The article termed a kitchener, now very commonly used instead of an old-fashioned kitchen range, has become very well known within a few years. The upper part of the fire-place is entirely closed, and the usual passage from it to the chimney is by flues round the oven and boiler. The kitchener is scarcely ever known to smoke, even with a very low chimney, which is to be accounted for by the fact, that none but highly-heated air can enter the chimney from the flues, the ascensional force of which is sufficient to overcome any pressure of an opposite nature.

Mr. Billing's Terminals for Chimneys.

This little treatise would be decidedly imperfect without an examination of the mode of finishing the tops of chimneys which was introduced by the late Mr. Billing, and which has been of late somewhat extensively applied. Fig. 36 represents a piece of earthenware, which is placed at the top of a chimney for the purpose of considerably reducing the aperture by which the smoke can escape; and fig. 35, another piece of earthenware, used to form a division between two chimneys, or to enclose a chimney on two sides. Both articles are shown in position in fig. 37. In fig. 39, the division piece, a little different in form to fig. 35, is seen to terminate the chimney stacks, the ordinary chimney pots being, of course, dispensed with.

The author is not aware what is the real nature of the benefit elaimed to arise by the use of these simple contrivanees, and he will, therefore, endeavor to examine in what way they appear calculated to affect, or to improve, the aetion of a chimney.

It has been seen that when a downward current exists in a chimney, and smoke issues from one adjoining, that this smoke oeeasionally passes into the downward eurrent, and descends to a room where there is no fire burning. It has been pointed out that the evil ean be remedied by supplying the room in which the nuisance occurs a little more freely with air, that the descending current may be ehecked, or converted into an upward eurrent; and, that a convenient and effectual means of closing the chimney may be of service on such an occasion. The evil may, however, be met by such a eontrivance as fig. 35, which answers the same as the piece of stone reeommended at page 22. If this division piece be placed between two ehimneys at top, the air and smoke issuing from one will pass off at the sides whieh are not blocked, and a descending eurrent in an adjoining ehimney will, with eonsiderably less probability, earry smoke with it. But, returned smoke in a vacant fire-plaee is not a common evil, and, as the other means indicated for avoiding it are such as improve the eondition of habitable rooms and the effectual working of a fire-place, they may be considered the preferable. The division piece may answer, however, a more useful purpose. No chimney staek ean be left with a flat surfaee at top. The old ehimney pot had its use in breaking the force of the wind, and, if the division piece is found to answer the same purpose as effeetually, it may be used as a substitute for an old form.

The first effect whieh a reduetion of the aperture at the top of a ehimney, by fig. 36, appears calculated to produce,

is to check the ascent of the heated column of air. That it does so, may be considered evident from the fact, that a partial closing of the regulator or register in the fire-place checks the quantity of air that can enter the chimney. In a water pipe or a gas pipe a check of the same description greatly diminishes the force and quantity of the issuing air or liquid. At the top of a chimney the same causes operate as at the bottom, though different in degree. There is the air expanded by heat, the pressure upwards from below, and the resisting medium above; and, there appears to be no other difference between the check at the top of a chimney and the one at bottom, than that the former is permanent, but that the latter can be used or not at pleasure. As, however, it has been shown that it is often advisable to establish an upward current in a fire-place with some rapidity, for the purpose of effectually carrying off the smoke, which current should be diminished as soon as the object has been gained, the check to be used or not at pleasure will be considered preferable to the permanent one.

There is, however, another aspect of the case. Are our chimneys of the most useful dimensions for performing their office, or are they invariably too large? If they are too large, is it not useful to diminish the size at top, for the purpose of preventing as much as possible the entrance of cold air, and to offer as small a surface as possible to the action of the wind? The only answer to the last question must certainly be in the affirmative; but, anything more than this simple admission should entail a discussion of the whole subject relative to the best dimensions for chimneys. This can be more properly dealt with in a treatise addressed particularly to our architects and builders; but, it will be sufficient for the present purpose to remark, that the dimensions of a chimney should neces-

sarily correspond to the quantity of air it is required to remove, which again depends on the size of the fire and the description of grate in use. As our chimneys are almost universally of the same dimensions, it follows, that what is sufficient for one apartment is much more than sufficient for another. A chimney from a small fire, with a contracted grate, may be greatly reduced; but, one from a large fire should be dealt with very cautiously. We may therefore consider that the article, fig. 36, is of benefit in all cases when the aperture is fully sufficient for the passage of the heated air, gases, &c., which may at any moment be ready to escape. If, on the contrary, it be used at any time with an aperture insufficient in size, the checking of the upward current will enable the pressure of the air above to prevail; cold air may enter the chimney and the products of combustion be driven back. The contrivance, therefore, should be used with caution to existing buildings; but, with reference to buildings yet to be constructed, demonstration is hardly necessary to prove, that its use should be superseded by the chimneys being constructed of the dimensions which are best adapted to answer their intended purpose.

We may now ask whether or not the division plate and a reduced aperture can serve a purpose of protection against wind. It has been, perhaps, sufficiently proved that chimneys do not generally require such protection except when their tops are contiguous to something of greater elevation, by means of which a descending power is given to the wind. If we look at the sketch, fig. 37, it will hardly appear that the division plate can often protect the aperture for the smoke. What is wanted in such a case is a simple roof, as in fig. 38, which was put to a house in Park Village, Regent's Park, on its construction many years ago.

Concluding Observations.

The above causes probably account for ninety-nine per cent. of all the smoky chimneys that exist, and, it is doubtful, indeed, if there be any other that is not almost identical with some one of those described. It will now be evident to any person not versed in such matters, who may have given the preceding observations a little careful consideration, that the idea of there being any universal cure for a smoky chimney is very preposterous, and can only have arisen in the minds of those who have not pursued any investigation upon a scientific basis, or whose experience in such matters has been of very limited extent. But though the causes for a chimney smoking are various, they all proceed from a disregard of general principles very few in number. For the sake of perspicuity, every distinct cause has been stated and examined by itself, and it is hoped that the particulars given are sufficient to indicate what are the very few cases of real difficulty, and to enable a person of intelligence to decide upon, and to apply, an appropriate remedy in any instance in which he may happen to be a sufferer. Though, however, the distinct causes are numerous, and the remedies various, it may be shown that the whole question is one of very great simplicity.

The fifteen causes mentioned may be placed under three divisions, as follows :—

First Division.

Chimneys that smoke in consequence of a descending current existing, or being produced in the chimney, irrespective of wind.

CAUSES.	REMEDIES.
Cause 1.—From a fire-place being too open.	To contract the size of the fire-place, or use a contracted grate.
Cause 2.—From the doors and windows of a room being fitted too closely.	To supply air by means of doors and windows, or to give a special supply near to the fire.
Cause 3. — From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.	To contract the opening into the chimneys. To use grates or registers that will not allow much air to ascend the chimneys. To give an additional supply of air if necessary.
Cause 4. — From a chimney being very short.	To use a contracted grate with a blower. To reduce the height of the fire-place. To reduce the opening into the chimney at top when too large. To heighten the chimney.
Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.	To use a very contracted grate with a blower. To reduce the size of the chimney at top when too large. To improve the construction of the chimney.
Cause 6.—From a chim-	To improve the construc-

ney being exposed on two or three sides to the action of air; the exposed brickwork not being sufficiently thick.	tion of the chimney. To use a very contracted grate with a blower. To reduce the size of the chimney at top when too large.
Cause 7. — From low buildings being attached to higher ones, in which the air becomes rarefied, there being direct means of communication between the two.	To supply the house and room liberally with air. To fit tightly the door of communication, or use a double door. To use a contracted grate with a blower. To heighten the chimney. To reduce the size of the chimney at top when too large.
Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.	To supply the room properly with air. To place a division piece of stone between the chimneys at top of about eighteen inches in height. To use a carefully fitted regulator to the chimney.

Second Division.

Chimneys that smoke from the effect of wind.

CAUSES.	REMEDIES.
Cause 9.—From the top of a chimney being situated below a pitched roof.	To heighten the chimney that its top may be above the source of obstruction. To use a simple protection.
Cause 10.—From the top of a chimney being situated near to a tower, or similar source of obstruction to the wind.	To heighten the chimney. To use a simple protection.

Cause 11.—From low buildings with short chimneys being contiguous to higher buildings.	To use the most contracted grate, and supply air below in moderate abundance. To reduce the size of the chimney at top when too large. To heighten the chimney. To put a simple protection at top.
Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.	To build the chimneys of the extreme height of the main building. To use the remedies indicated for cause 4. To use a simple protection at top.
Clause 13.—From chimneys of one house being lower than those of one adjoining.	To heighten the chimneys. To put a protecting roof, as fig. 13 or 22.
Clause 14.—From chimneys in elevated situations being exposed to heavy gales of wind.	To use a protection constructed on such principles as are indicated in figs. 19 to 25.

Third Division.

Chimneys that smoke in consequence of their being too small.

CAUSES.	REMEDIES.
Cause 15.—From a chimney being too small for the fire-grate used.	To use a grate and regulator that will allow a minimum quantity of air to ascend the chimney. To reconstruct the chimney. To use a stove.
Cause 16. — From two	To use well-contracted

fire-places being used to one chimney.	grates, with carefully fitted regulators. To supply rooms sufficiently with air.

It is seen by the above table that nearly all our smoky chimneys are occasioned by two general causes, viz, the descent of cold air in a chimney, and the fall of wind on the top of a chimney, caused by some neighboring obstruction. The third general cause is very rarely encountered. We can now make some interesting reflections relative to the mode which has usually been adopted for the prevention of nuisance by smoke. What has been a source of perplexity to thousands, nay hundreds of thousands of persons, has simply been, that they have entirely confounded the first general cause with the second, both being, in fact, entirely distinct, and to be encountered by different remedies. If the descent of cold air in a chimney be reversed by some of the various means indicated, the wind itself will be found to be, by no means, the difficult subject to deal with that is generally supposed, and the thousand various forms which have been invented to wile away, or to protect against, the wind, may, to the benefit of the national taste, pass quickly into oblivion. A few of the amusing forms, however, will be preserved in the pages of the lamented Mr. John Leech, where he gives his celebrated Mr. Briggs contemplating his builder's operations on the roof of his house. We have seen that most chimneys are not affected by the wind, except when they are situated below something contiguous, as a roof, a neighboring stack of chimneys, a higher house or neighboring hills, and that, therefore, chimneys in general do not require any protection whatever. It can, in fact, be proved by overwhelming evidence, that when bodies of air move unobstructed over our heads on the same plane as the

horizon, they do not, except in very exposed situations, affect our chimneys to any appreciable degree. We have only to look around us, and we shall see that the number of chimneys to which it has not been considered necessary to apply a protection, is by far the most considerable, and that, in many recent buildings, no trace whatever of such a thing is to be found. Fig. 40 represents a portion of the roof of the National Provident Institution, from the designs of Professor Kerr, in which the chimneys are raised high, as they should be; and fig. 39, the roof of Montagu House, Whitehall, in which the same precaution has been taken. A most excellent example is the Charing Cross Railway Station and Hotel.

Recommendations to builders and others for the avoidance of smoky chimneys in new buildings.

Rule 1.—To use grates of a contracted form, fitted with proper regulators, and to avoid grates with hobs.

Rule 2.—To avoid fitting doors and windows so as to practically exclude fresh air from a room; or to give a special supply of air near to a fire, in sufficient quantity, for which particulars have already been given.

Rule 3.—To build chimney stacks in all cases as high as the highest part of the roof, and to terminate them by chimney pots, or by Mr. Billing's division piece.

Rule 4.—To terminate a chimney stack by a protecting roof, whenever a building is lower than an adjoining one, or whenever the chimney stack of one house is lower than a contiguous one of a house adjoining.

Rule 5.—To build all chimneys that are exposed on one side, or more, of nine-inch brickwork.

Rule 6.—To build all short chimneys of smaller dimensions than usual. Nine inches by four and a half inches

are sufficient for the fire-places of attics, &c., containing a thousand cubic feet of air, if contracted grates are used. Larger rooms may have chimneys fourteen inches by four and a half, and rooms containing five thousand cubic feet of air may have them eighteen inches by four and a half.

Rule 7.—To construct the fire-place of a low chimney not exceeding thirty inches in height.

Rule 8.—In constructing an extra room with immediate communication from the main building: to build a good chimney, if possible, against the main building, and terminate it as by Rule 3.

Rule 9.—When it is impracticable to build a lofty chimney against the main building, to construct the chimney no larger than amply sufficient: to use a contracted grate, with a blower; to build the chimney as high as may be convenient; to construct a low fire-place; to give a special supply of air near to the fire; to place a protecting roof to the chimney; and, if the air in the house or building is likely to be generally more rarefied than the air in the added portion, to fit tightly the door of communication, or construct a double door. The last two rules are intended to avoid the causes 7 and 12.

Rule 10.—To provide chimneys in very elevated situations, with a simple protection against the wind arranged on principles similar to those indicated.

It may be hoped it is now obvious, that by attention to such general rules as the due supply of air to houses and rooms, the use of contracted fire-places, attention to the proper construction of chimneys, and the use occasionally of some simple protection, smoky chimneys may be everywhere successfully dealt with, and rendered very unnecessary possibilities in the future. May it not also be

considered evident, that elegance or neatness of form need never be sacrificed to utility, and that, if excellent designs are often marred by unsightly terminations to chimneys, this is simply in consequence of two important subjects being unequally understood? None will be more thankful than our very useful body of architects to be relieved from unsightly nuisance; and if, with minds already considerably practised on the subject, they should have their attention directed to these pages, the author's labor may not have been in vain, and he may have reason to be thankful that he has had an opportunity to render one slight service to his country.

The question of the ventilation of our apartments, together with the utilization, to a considerable extent, of the heated products of our fires, and the most efficient construction of our chimneys, the author has discussed in another treatise. He is convinced that a true and effective system of ventilation need not interfere with the due warming of our apartments, and that, the more both subjects are understood, the better they can be harmoniously combined.

Fig. 1. An old-fashioned grate, made entirely of metal, with large space over the fire.

Fig. 2. A contracted grate: *a*, *a*, *a*, fire brick back and slides; *b*, handle of regulator to chimney opening; *d*, *d*, openings to admit fresh air.

Fig. 3. Tranverse section of fig. 2: *a*, *a*, *a*, fire brick chamber; *b*, handle of regulator to chimney opening; *c*, regulating valve in chimney.

Fig. 4. Contracted grate with a sliding blower, *a*. The outer form shown in figs. 2 and 4 is not necessary, but it is most effectual for radiating heat. The more popular arched form for a grate is equally serviceable to contract the opening of a fire-place.

Fig 1.

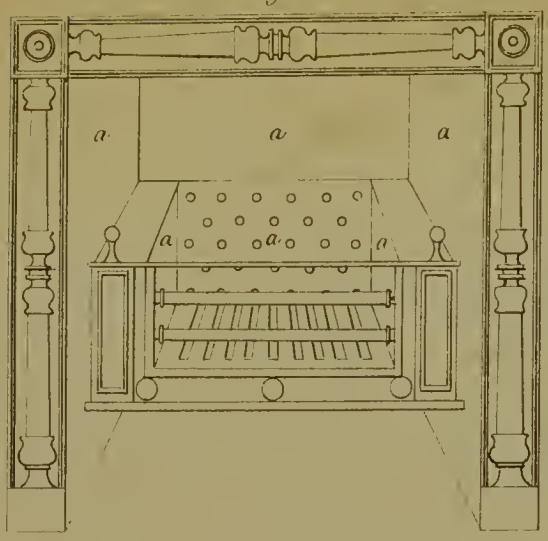
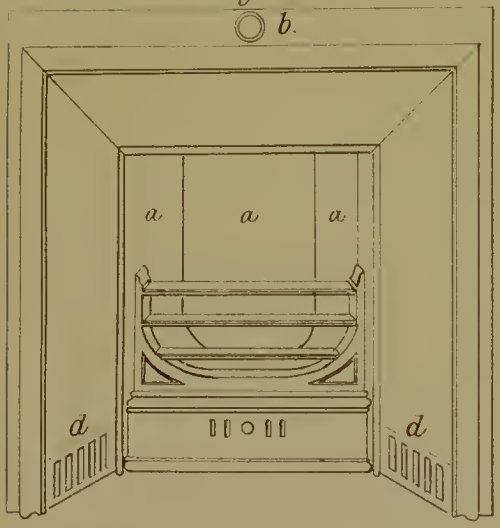
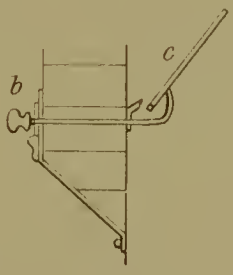


Fig. 2.





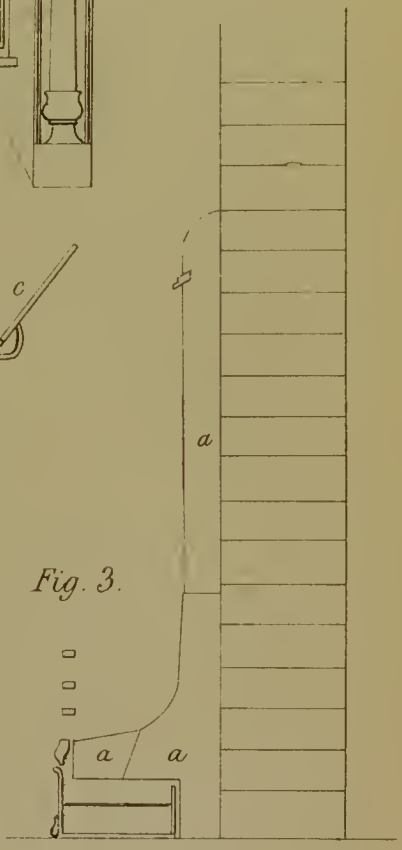


Fig. 3.

Fig. 4.

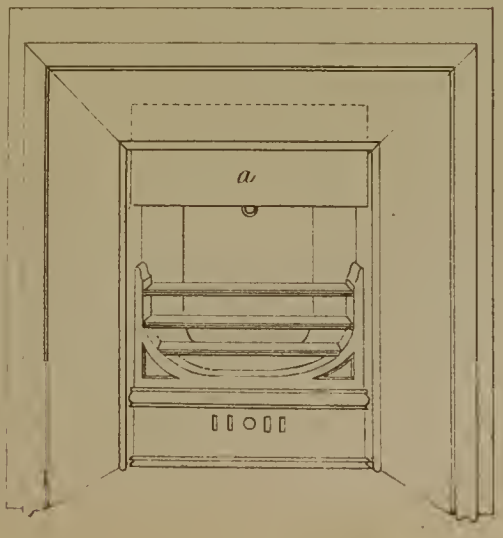


Fig. 5. Dog or pillar grate, as commonly used in an open fire-place.

Fig. 6. The same grate with the opening to the chimney much contracted.

a, *a*, sides of tile or other material.

b, front contracting plate.

c, regulator to chimney.

d, *d*, side contracting plates.

Fig. 7. The same grate as in fig. 6, with a sliding blower *e*.

Fig. 8. Transverse section showing the grate of fig. 5, with the opening above into the chimney contracted at *b*, and louvre plates, *a*, *a*, *a*, &c., to regulate a back draught into the chimney.

Fig. 6.

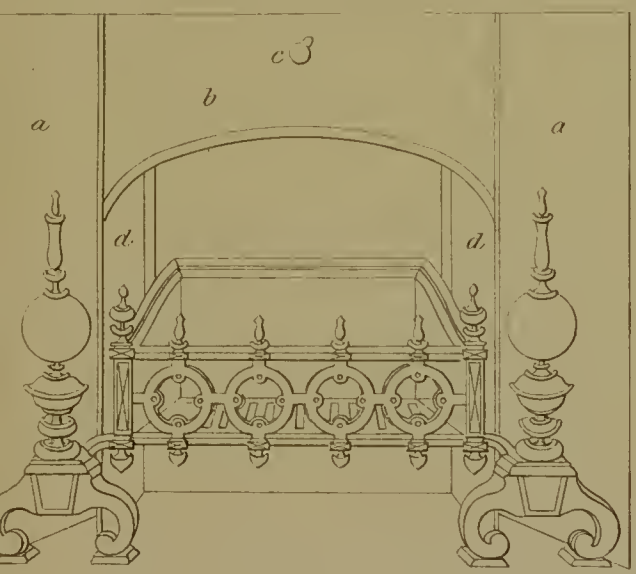


Fig. 8.

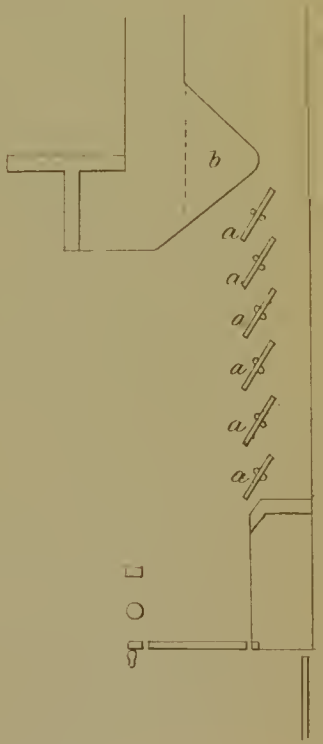


Fig. 7.

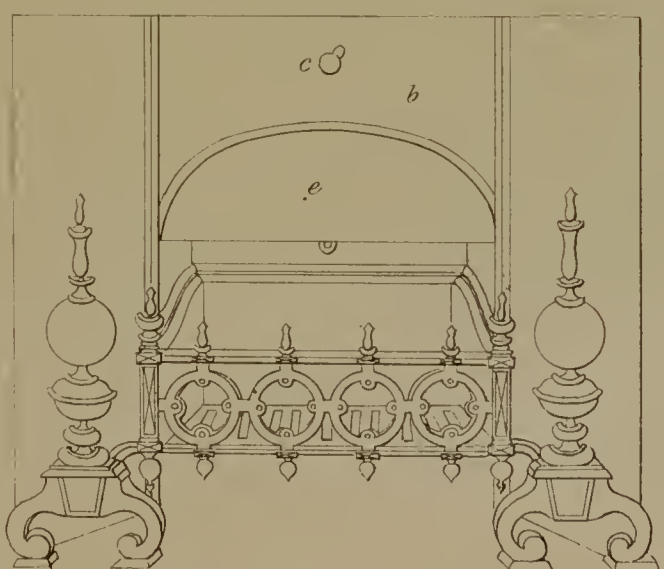


Fig. 9. A funnel-tube to reduce the opening into a short chimney, above the fire-place.

Fig. 10. An iron frame to fix in a chimney above the grate, to which the funnel-tube can be attached by turnbuckles at *a*, *a*.

Fig. 11. Stephen's patent grate.
a, door to chimney.

Fig. 12. Transverse section of fig. 8.

Fig. 13. King's patent grate.
a, sliding door to chimney.

Fig. 14. Transverse section of fig. 13.

Fig. 9.

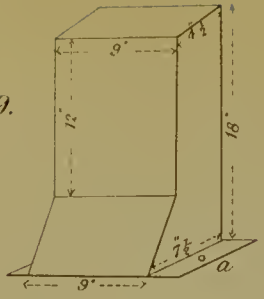


Fig. 10.

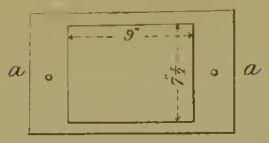


Fig. 11.

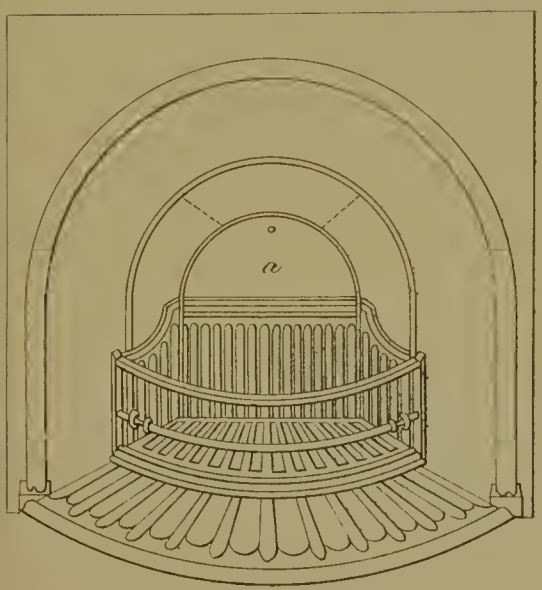


Fig. 12.

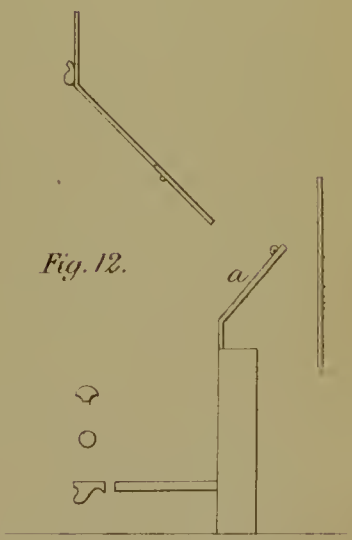


Fig. 13.

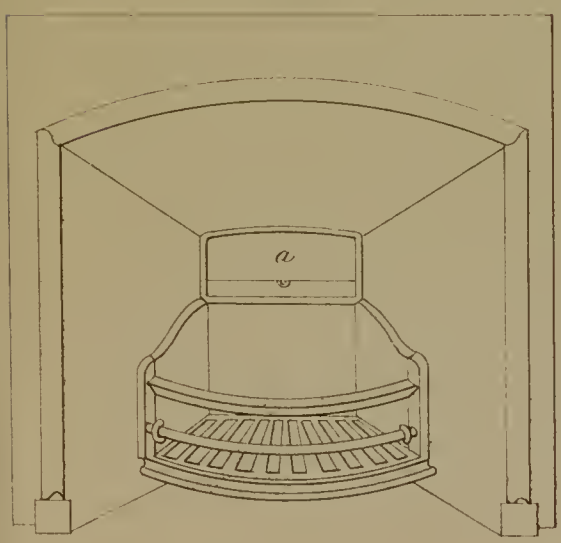


Fig. 14.

Fig. 15. Roof and upper portion of the Middle Temple Library, from a sketch in *The Builder* of December 15th, 1860.

a, *a*, tops of chimneys.

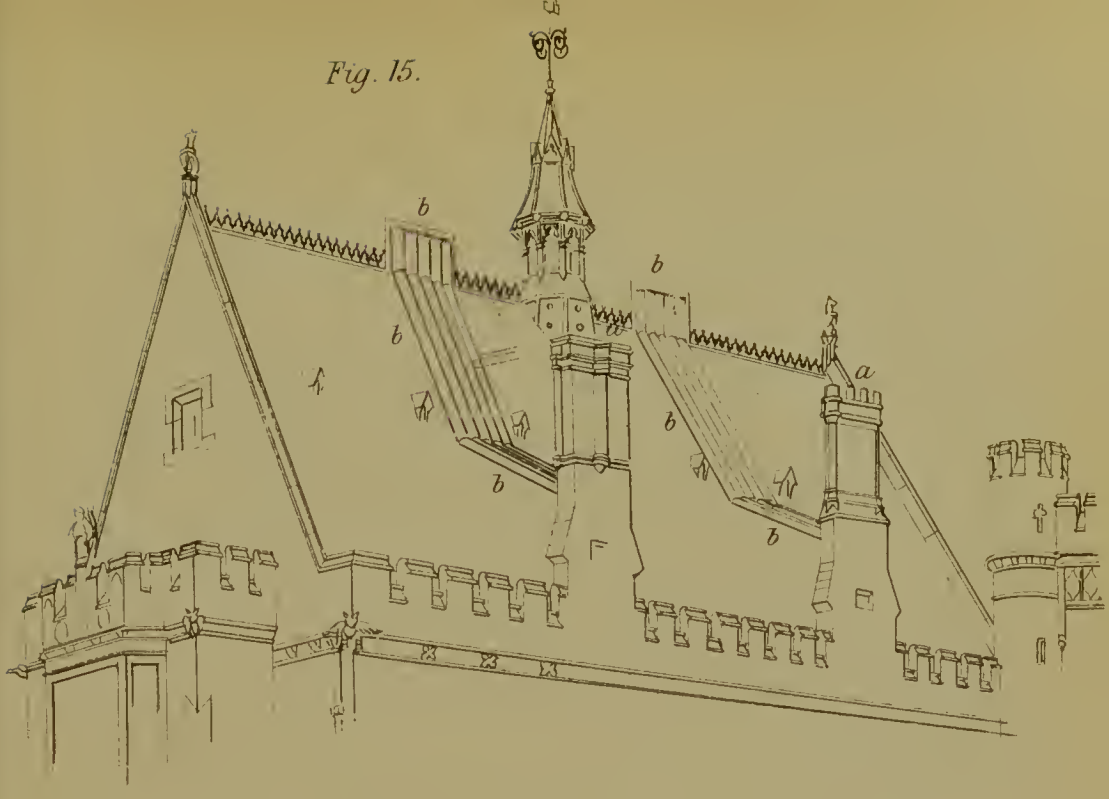
b, *b*, *b*, *b*, metal flues for the passage of the smoke.

Fig. 16. Transverse section of the roof, showing the chimneys closed at top and on the side nearest to the roof, and a shield, *c*, to protect the passage of smoke.

Fig. 17. Section of a simple form of protection against a descending force of wind.

Fig. 18. A similar protecting roof to several chimneys. Great care must be used in adopting this to allow free egress from the chimney. If the lower edge of the roof be two inches above the top edge of the brickwork, and six inches away from it, there will be no impediment to the escape of smoke.

Fig. 15.



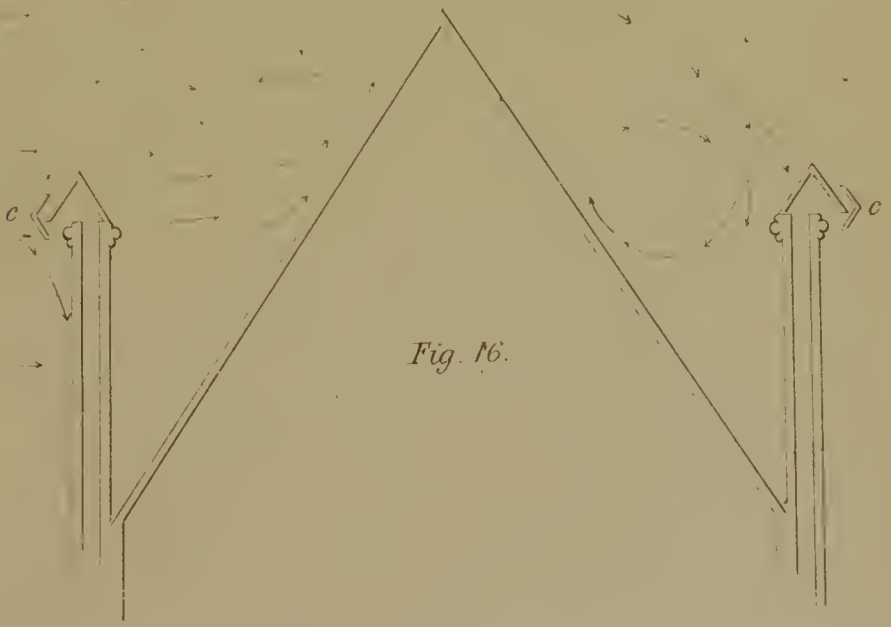


Fig. 16.

Fig. 18.

Fig. 17.

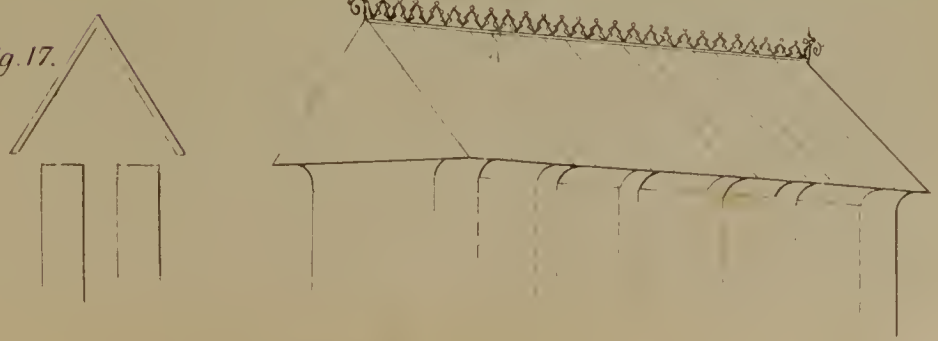


Fig. 19. A chimney wind-guard introduced by the Marquis de Chabannes.

Fig. 20. Section of fig. 19.

Fig. 21. Another wind-guard, introduced by the Marquis de Chabannes for extremely bad cases of down draught occasioned by wind.

Fig. 22. Section of fig. 21.

Fig. 23. A wind-guard introduced by Dr. Arnott.

Fig. 24. Section of fig. 23.

Fig. 25. The same wind-guard with a protection, a top at *a*, *a*, when used below higher buildings.

Fig. 19.

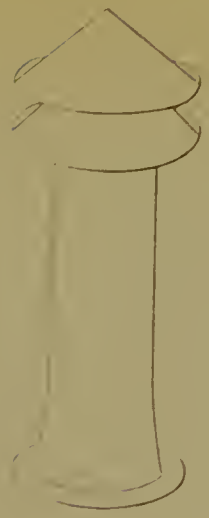
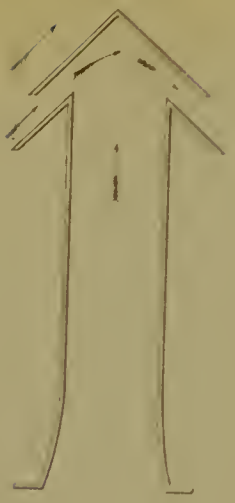


Fig. 20.



Fig

Fig. 21.

Fig. 22.

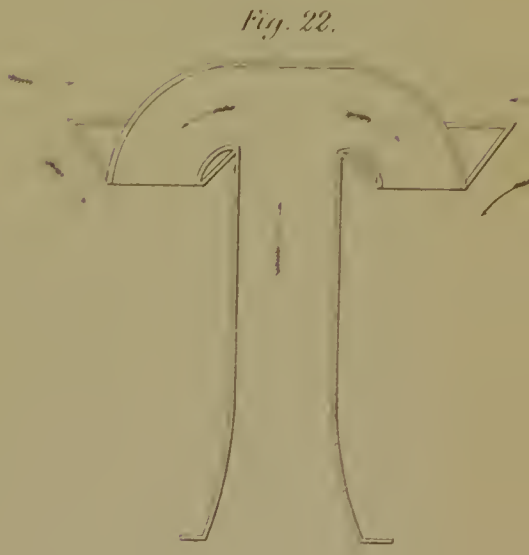


Fig. 23

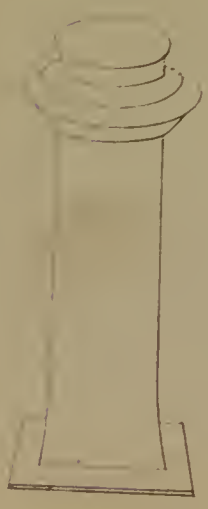


Fig. 24.

Fig. 25.

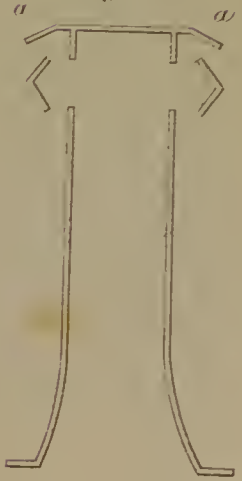


Fig. 26. An old-fashioned kitchen range with a blower, *c*; two side plates, *a*, *a*; and a front plate, *b*, to contract the opening leading to the chimney.

Fig. 27. Transverse section of a portion of fig. 15, showing the inclined plate, *b*, and the openings to chimney, *c*, *d*.

Fig. 28. Contracting plate for a common grate, as fig. 29, or a common range, as fig. 31.

Fig. 29. A grate composed of metal, with a large open space above, such as is now used in a laborer's cottage or in an attic fire-place.

Fig. 30. The same fire-place as fig. 5 contracted; *a*, *a*, *a*, fire-brick.

Fig. 26.

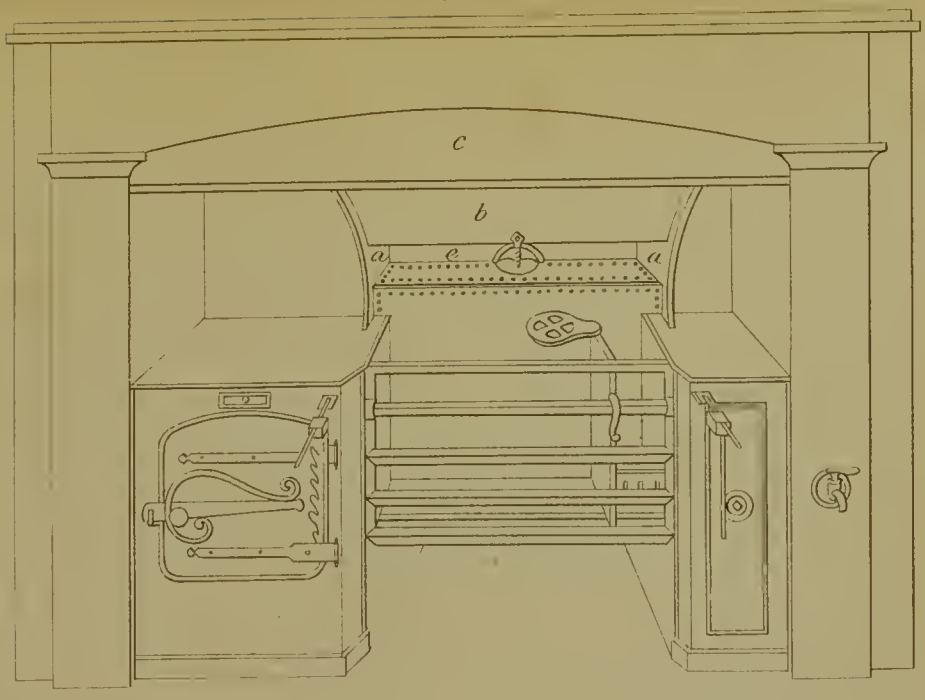


Fig. 27.

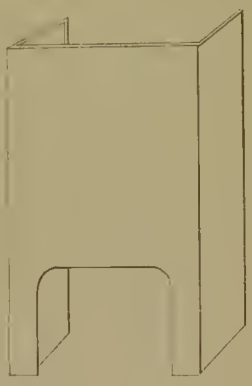


Fig. 28.

Fig. 29.

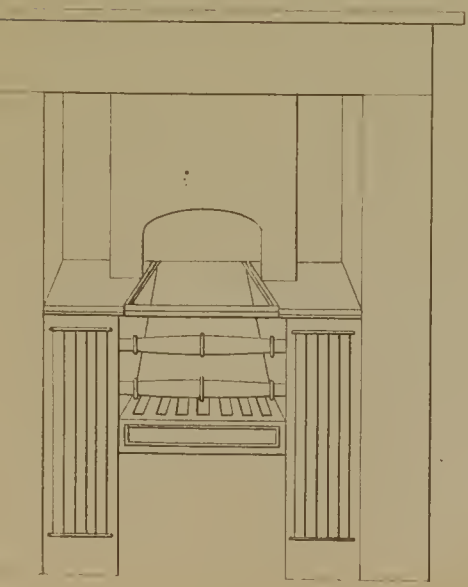
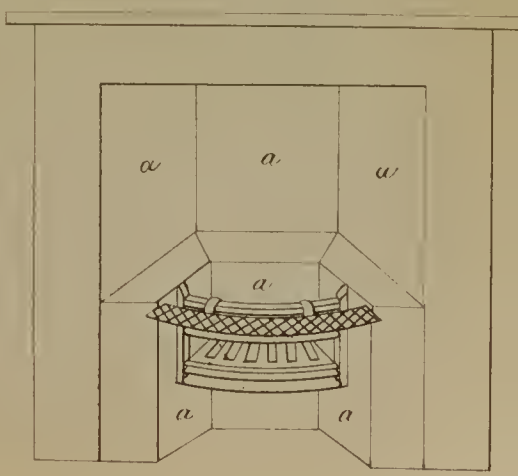


Fig. 30.



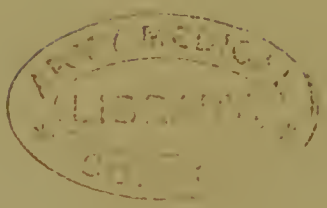


Fig. 31. An ordinary cottage range, with the back draught plate, *a*, fig. 28.

Fig. 32. Section showing back draught plate, *a*, and contraction to chimney, *b*.

Fig. 33. A close cooking-stove used independently of brickwork. No opening is allowed into the chimney except through the pipe.

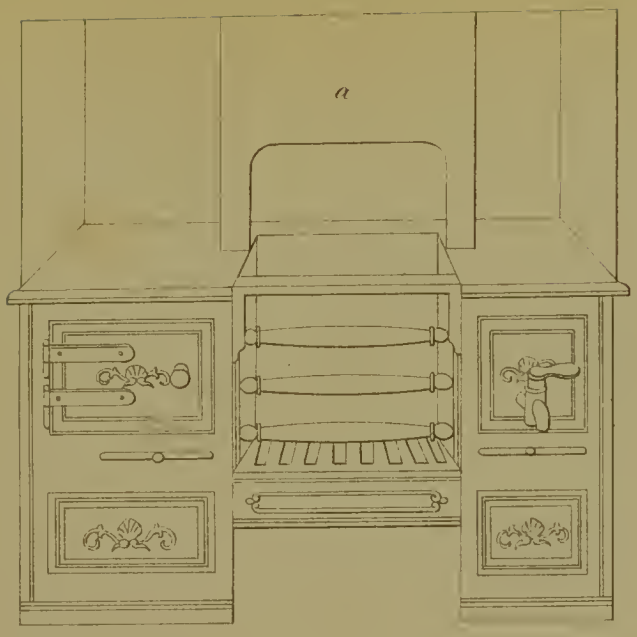
Fig. 34. Section of fig. 33, showing the stove fixed in a fire-place.

a, pipe to chimney.
b, register door.

Fig. 35. Division for the tops of chimneys in lieu of a chimney pot, suggested by the late Mr. Billing.

Fig. 36. Mr. Billing's reducing piece for the top of a chimney.

Fig. 31.



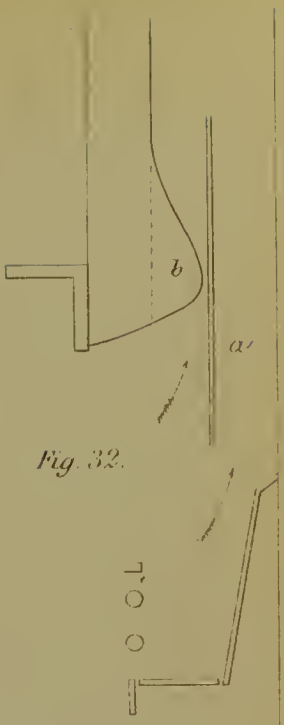
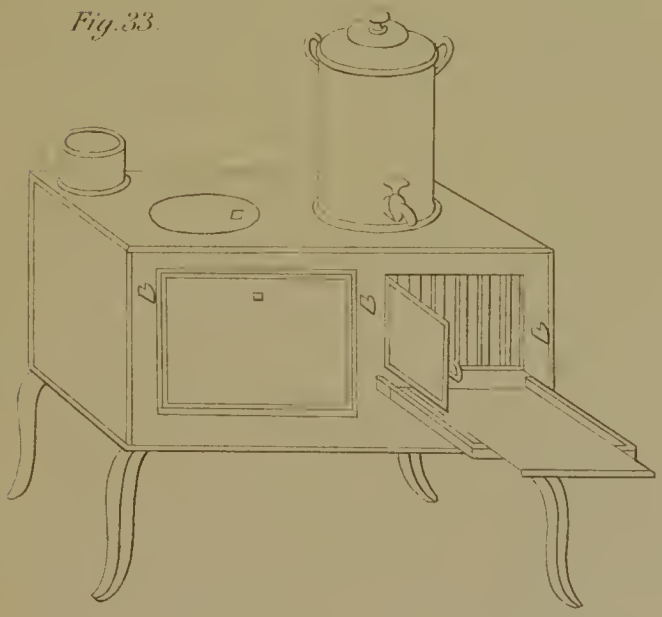


Fig. 32.

Fig. 33.



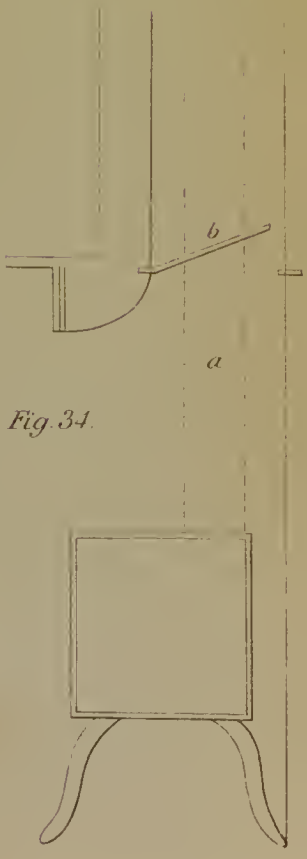


Fig. 34.

Fig. 35.

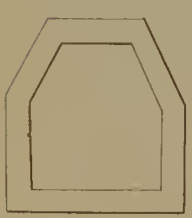


Fig. 36.

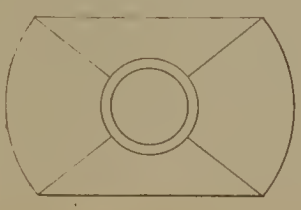


Fig. 37. The top of a stack of chimneys exhibiting the figs. 35 and 36.

Fig. 38. A proteeting roof to a stack of ehimneys.

Fig. 39. Sketeh of the upper portion of the National Provident Institution, Gracechurch Street, showing the elevated staeks of ehimneys. The sketch is taken from *The Builder* of January 3, 1863. A portion only of the details is given here.

Fig. 40. Roof and upper portion of a mansion in Whitehall, showing the elevated staeks of chimneys. This sketch is taken from the *Illustrated London News* of September 24th, 1864. A portion only of the details is given here.

Fig 37.

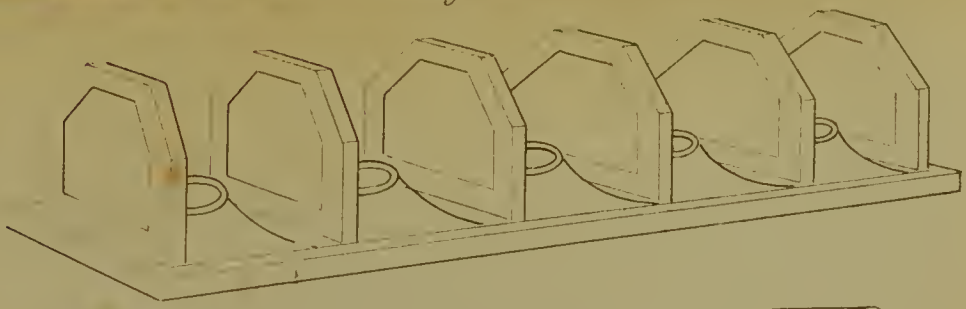


Fig. 38.

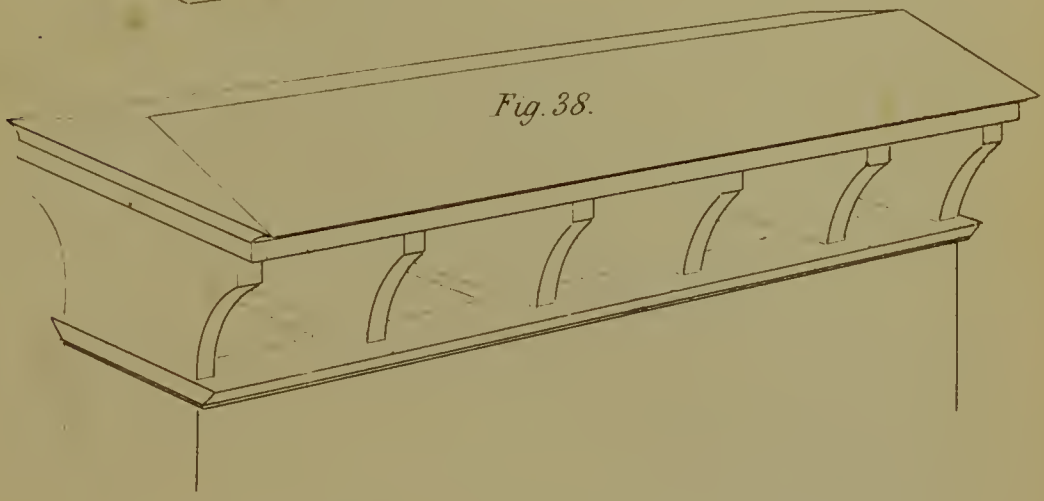


Fig. 39.

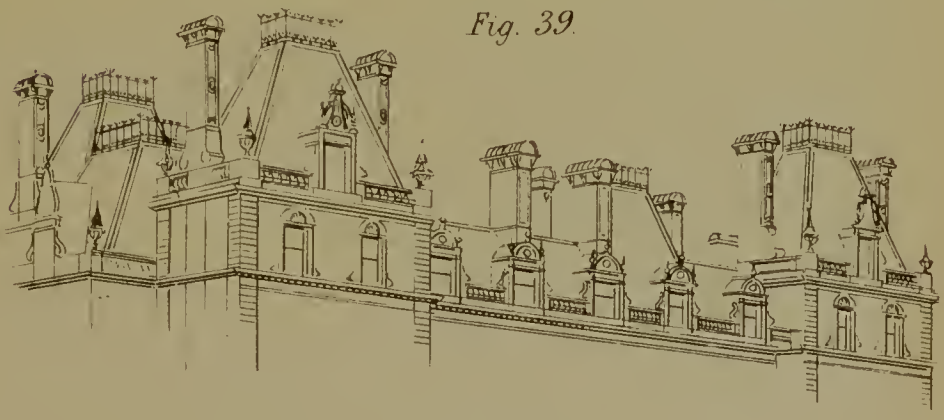


Fig. 40.